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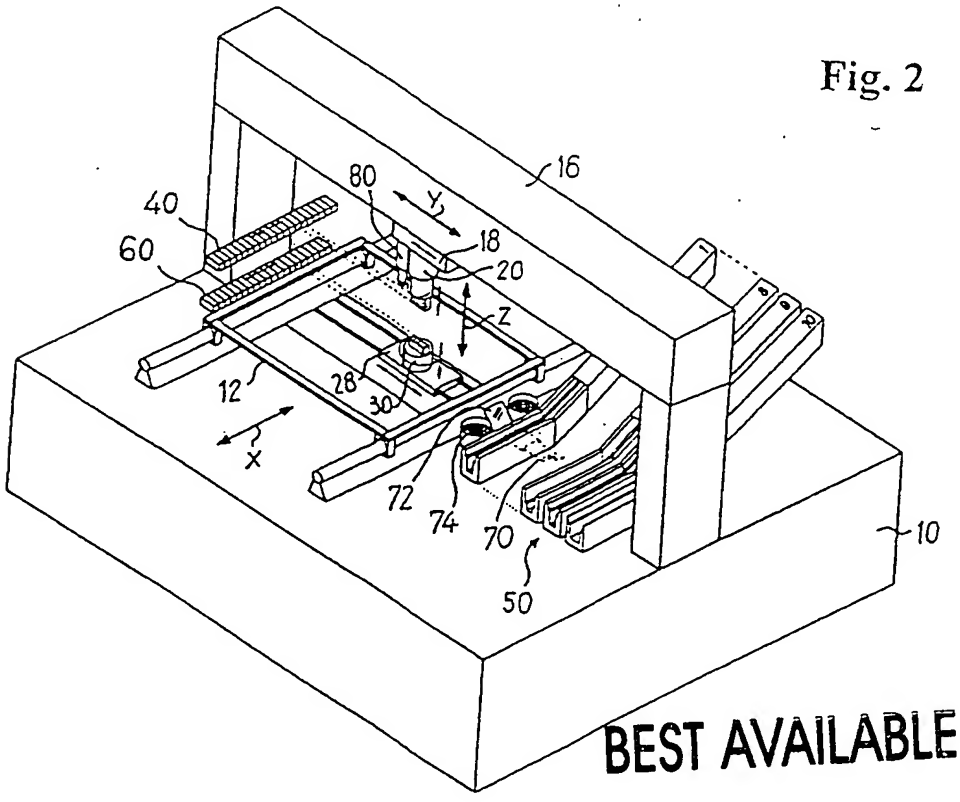
(54) Method and device for fitting electronic components in a printed circuit board

(57) The electronic components, provided with a series of contact pins, are picked up out of a feed unit (50) by a pickup-and-insertion head (20) which travels along the Y axis to above a table (12) on which is mounted the printed circuit board, and which can travel along the X axis.

The series of contact pins are pushed into the corresponding holes in the board after a visual inspection of the position of the contact pins and holes has been carried out.

This visual inspection is carried out by a camera (70) which is fixed-mounted between the feed unit and the table (12), and by a camera (80) which is mounted in the vicinity of the head (20) and which can travel with said head.

Fig. 2



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Description

This invention concerns a method and a device for fitting electronic components and others, more particularly for fitting connectors of the "press-fit" type in a printed circuit board, hereinafter referred to as "PCB".

Said press-fit connectors comprise a connector body in which a series of contact pins are fitted which project from the side or the bottom of the body.

The PCB is a relatively thin board of insulated material provided with a number of openings or holes which may or may not be connected with each other by means of a conducting material printed on the board.

The thickness of the PCB is not limited by the device, but by the characteristics of the connectors used.

Both the method and the device are suitable for handling male and female connectors, both in the straight and 90° versions.

Until now, these connectors were mostly fitted to the PCB manually, so that the efficiency and quality of the connections made could not always be assured under optimum conditions. Furthermore, said operations demand a considerable amount of skill and precision, and also involve exposure to dangerous operations, including pressing in the connectors under a heavy press.

Devices already exist which automatically take electronic components from a feed channel and press them into a PCB.

For example, there are devices fitted with a rotating head, with gripper arms that pick up components one after another and push them into a PCB. Such devices are known from among others Belgian patent BE 903.742 in the name of the applicant, and from German patent DE 3 424 323.

These devices are however only suitable for inserting simple contact pins or small electronic components in a PCB; they are insufficient for pressing in several contact pins at once, as is necessary for connectors which are already fitted with the required contact pins, since it is necessary to provide an insertion force of from 6 to 20 kg per contact pin, so that connectors which can have 200 or more contact pins require a pressure of around four tons.

Further, in order to insert a series of contact pins for a connector, it is necessary to ensure that the ends of the contact pins are all exactly in line with each other, in order to prevent the pins being damaged when they are inserted into the corresponding holes in the PCB.

Patent US-A-4.718.165 describes a device equipped with a pickup head for picking up connectors and inserting them with their contact pins into the corresponding holes of a PCB. Said device has a means in the form of a double comb which correctly aligns the contact pins before they are inserted into the PCB. The device according to said invention is provided with means for picking up, aligning and inserting contact pins of a single type (long) of connector. Furthermore, the means for aligning the contacts are mechanically complicated and time-consuming, so that a continuous movement of the various operations is not possible.

The aim of the present invention is to ensure fully automatic and continuous insertion of press-fit connectors in a PCB, where the correct insertion of the different contact pins in the corresponding holes of the PCB is ensured by a visual inspection, followed by correction of the position of the pins with respect to the holes.

A second aim of the invention is to propose a device that makes it possible to pick up a great number of different types of connectors from their respective feed channels and insert them selectively into the PCB.

A third aim of the invention is to considerably increase the operating speed and reliability of the above-mentioned operations.

In order to achieve these aims, the method and the device according to the invention are characterised by operations and means which are further explained in the claims that follow the description.

In order to better explain the invention and further characteristics thereof, a particular embodiment is described below, with reference to the attached drawings, where:

- Fig. 1 is a schematic representation of the arrangement and movements of the main components of the device;
- Fig. 2 is a perspective view of a device fitted according to the invention with the means for visual inspection.

The main components of the invention are shown schematically in Fig. 1 and comprise a fixed base 10, with a centrally arranged table 12 on which one or more PCBs 14 are fixed. The table 12 can travel along an X axis transversely underneath a gantry 16 whose vertical pillars are attached at the bottom to the fixed base 10.

A gantry arrangement has been chosen because of the accuracy and stability of the whole. The gantry 16 and the base 10 are preferably made of granite.

With a portal arrangement, the accuracy is under better control than with an X-Y table. A gantry enables picking up and inserting to be done directly, and furthermore makes it possible for the device to be included in a production line with automatic input and output of components and finished products.

Under the cross-beam of the gantry 16 is fitted a slide 18 which can travel along a Y axis, and which therefore travels transversely over the table 12 between the vertical pillars of the gantry 16.

The slide 18 is fitted with a pickup-and-insertion head 20 which can move up and down along the Z axis, which can also carry out a rotational movement.

A gripper mechanism 22 arranged underneath the head 20 can thus move with respect to the PCB 14 as follows: transversely across the PCB, up and down, and in rotation.

Underneath the PCB is a support mechanism in the

form of an anvil 30 which is also mounted on a slide 28 and which can travel along a Y axis like the head 20.

The anvil 30 can like the head 20 move up and down along a Z axis, and carry out a rotation motion.

The top side of the anvil 30 is provided with a receiving mechanism 32 which can move underneath the PCB as follows with respect to same: transversely underneath the PCB, up and down and in rotation.

In order to enable different types of connectors to be picked up and inserted into the PCB, the gripper mechanism 22 of the head 20, and the receiving mechanism 32 of the anvil 30, are respectively equipped with means for automatically picking up suitable tools from the respective magazines 40 and 60, where said tools make it possible to pick up each specific connector from one of the feed channels 50 in order to insert it into the PCB, with the PCB being supported by a suitable tool on the anvil 30.

For each type of connector, the device requires a toolset.

Said toolset comprises a bottom tool for the anvil 30 and a top tool for the pickup-and-insertion head 20.

The different top tools for the head 20 are located in a magazine 40 mounted on one side of the gantry 16, above the level of the table 12.

The various corresponding tools for the anvil 30 are located in a magazine 60 mounted on the same side as the magazine 40 but underneath the level of the table 12.

Both tool magazines 40 and 60 are moveably mounted so that they can travel along an X axis, i.e. transversely with respect to the Y axis of the head 20 and the anvil 30.

Each of the tools which can be located in the magazines 40 and 60 can thus be presented straight opposite the gripper mechanism 22 of the head 20 and the receiving mechanism 32 of the anvil 30 respectively.

Once an appropriate top tool has been taken out of the magazine 40 by the mechanism 22 of the head 20, and a corresponding bottom mechanism has been picked up by the mechanism 32 of the anvil 30, the slide 18 of the head 20 can travel along the Y axis to the other side of the gantry 16 where a series of feed channels 50 or analogue are mounted, and from which the appropriate connector can be picked up and held fast by the head 20.

In the meantime, the bottom tool of the anvil 30 positions itself underneath the holes in the PCB into which the pins of the selected connector are to be inserted.

As a result of the rotation movement of the head 20 and of the anvil 30 respectively, a connector can be picked out of a feed channel 50 lying in a direction along the X axis, and can then be rotated and subsequently inserted into the PCB along the Y axis, where said PCB is supported by the bottom tool of the anvil 30, which has also rotated for this purpose.

The tool change is carried out automatically, according to the PCB component mounting program (computer program) stored in the control unit of the device, which is not further described here.

According to the invention, during the movement of the head 20, with the connector that has been picked up, between feed channel 50 and the PCB 14, a visual inspection is carried out of the position of the contact pins of the connector that has been picked up, and of the position of the holes in the PCB into which the pins have to be inserted.

Fig. 2 shows the arrangement of the means which enable this visual inspection to be carried out. Said means can be e.g. cameras.

A fixed camera 70 is mounted between the feed channels 50 and the table 12 (PCB): Each connector that is picked up is moved above the camera 70 by means of the pickup head 20, so that an image of the underneath of the connector is registered by the optical axis of said camera 70, this is directly or via a mirror 72.

The necessary light is provided by lamps 74, of the halogen lamp or light-emitting diode type, which preferably emit a diffuse light.

The focus plane of the camera 70 is fixed, and the focus field of the camera must therefore be adjusted by an up-and-down movement (along the Z axis) of the pickup-and-insertion head 20.

The camera 70 is preferably of the asynchronous shutter array CCD type, with which still images can be made of the underneath of the moving connector (with the contact pins sticking out).

The position of the contact pins and/or connector housing with respect to the centre of the insertion axis is determined from the image or series of images.

A second camera 80 is mounted on the slide 18 of the pickup-and-insertion head 20, where said second camera 80 is preferably a normal array CCD type, which can visualise the position of the corresponding holes in the PCB.

By means of the slide 18, the camera 80 can be positioned transversely over the PCB. The optical axis of the camera 80 is displaced by a known distance along the X and Y axis with respect to the axis of the head 20.

The camera 80 is placed above a hole in the PCB in a position where the hole should actually be, without taking finishing tolerances into account. The centre of the hole is calculated from the actual camera position.

By carrying out several measurements for each PCB, the actual positions of the drill pattern can be found (measured).

Since the camera 80 is mounted on the slide 18, it must be fitted with self-adjusting focus, so that the image can be focused on the holes or on already mounted components or connectors.

During the transport or the flight of the connector from the one feed channel 50 to a mounting position above the PCB, the images of the two cameras 70 and 80 are superimposed and compared, so that an XY correction can be carried out, such that the connector contact pins can be positioned in the centres of the corre-

sponding holes with as close an average approximation as possible. If according to the images no successful component mounting is possible, the connector is rejected.

As an extra safety check, the pickup-and-insertion head 20 can, as already known from similar devices, be fitted with a force measuring unit whose output signal is proportional to the insertion force. For each type of connector, an ideal force diagram is stored in the control unit (computer). For each component mounting operation, the actual force curve is measured and compared with the normal diagram. If the difference from the force exerted is "too large" or "too small", the machine is stopped.

It should be obvious that the method and the device according to the present invention also can be operated in "inverse" mode, which means that the camera 80 also can carry out the visual inspection of the position of terminals of an already installed connector and that camera 70 looks for the position of the holes in a connector shroud to be placed on pins of an already installed first connector.

The most important advantages associated with the device according to the invention are:

- great reliability of the finished PCBs;
- high reliability of the component mounting of the PCB, even for differing types of connectors;
- great flexibility of applications: handling several PCBs at once, fitting connectors with straight downwards or sideways contact pins, or pins at 90°;
- ability to insert press-fit connectors with more than 150 contact pins at once;
- simple mechanical construction and efficient arrangement of the moving parts (table, pickup-and-insertion head, and anvil).

Claims

1. Method for fitting electronic components, provided with a series of contact pins, into an other component such as a printed circuit board (14), where a pickup-and-insertion head (20) travels in a particular direction (Y) between a feed unit (50) for components and a table (12) which can travel in another direction (X) and on which the other component (14) is mounted, characterised in that
during the movement of the pickup-and-insertion head (20), which has picked up an electronic component from the feed unit (50), between the feed unit (50) and the table (12) with the other component (14), a visual inspection is carried out of the component with its contact pins, in order to determine the actual position of the pin(s) in a first image, which can be compared with the position of the corresponding hole(s) in the other component (14).

2. Method according to claim 1, characterised in that a visual inspection is carried out of the position of at least one hole in the component (14), where a second image of the actual position of the hole (holes) is obtained, whereupon the first and second images are superimposed in order to make a comparison possible, and if necessary an XY correction can be applied in order to position the contact pins of the component as closely as possible in the centre of the corresponding holes in the other component (14).

3. Device for fitting electronic components provided with a series of contact pins, in a printed circuit board (14), where the device is essentially provided with a subframe or base (10) on which is mounted a table (12) which can travel in a first direction (X), and with a pickup-and-insertion head (20) which can travel in a second direction (Y) above the table (12), perpendicular to the first direction, between a feed unit (50) for components and the table (12) on which the board (14) is mounted, characterised in that
between the feed unit (50) and the table (12), visual inspection means (70) are fitted which make it possible to make a first image of the actual position of the contact pins of the component that has been picked up.

4. Device according to claim 3, characterised in that in the vicinity of the pickup-and-insertion head (20), visual inspection means (50) are mounted which travel with the head (20) and can be positioned transversely over the board (14) to register a second image that determines the actual position of the holes in the board (14).

5. Device according to claim 3, characterised in that the pickup-and-insertion head (20) is mounted on a slide (18) which can travel transversely (along a Y axis) above the table (12) and which is mounted underneath the cross-beam of a gantry (16) which is connected underneath by its vertical pillars to the fixed base (10).

6. Device according to claim 5, characterised in that the base (10) and the gantry (16) are made of granite.

7. Device according to claim 3, characterised in that underneath the table (12) is a support mechanism in the form of an anvil (30), which is mounted on a slide (28) and which can travel along a Y axis and which can also move up and down along the Z axis, in order to be able to support the board (14) while a series of contact pins are being pushed in.

8. Device according to claim 3, characterised in that

the pickup-and-insertion device (20) is fitted on the underneath with a gripper mechanism (22) that makes it possible, for each different type of electronic component, to pick up a suitable tool from a magazine (40) mounted on the side of the gantry (16) opposite the feed unit (50), at a level higher than the table (12).

9. Device according to claim 7, characterised in that the top side of the anvil (30) is fitted with a receiving mechanism (32) that makes it possible, for each different type of electronic component, to receive a suitable tool from a magazine (60) mounted on the side of the gantry (16) situated opposite the feed unit (50), at a level higher than that of the table (12).

10. Device according to claim 3, characterised in that the visual inspection means (70) consist of a camera of the asynchronous shutter array CCD type, with which still images can be made of the underneath of the moving part with the projecting contact pins or with holes in another connector shroud.

11. Device according to claim 4, characterised in that the visual inspection means (80) consist of a camera of the normal array CCD type, which determines the position of the corresponding holes in the board (14) or of the terminals in a already mounted component such as another connector.

12. Device according to claims 3 and 5, characterised in that
the pickup-and-insertion head (20) is fitted with a force measuring device whose output signal is proportional to the force with which the contact pins are pressed into the board (14).

Fig. 1

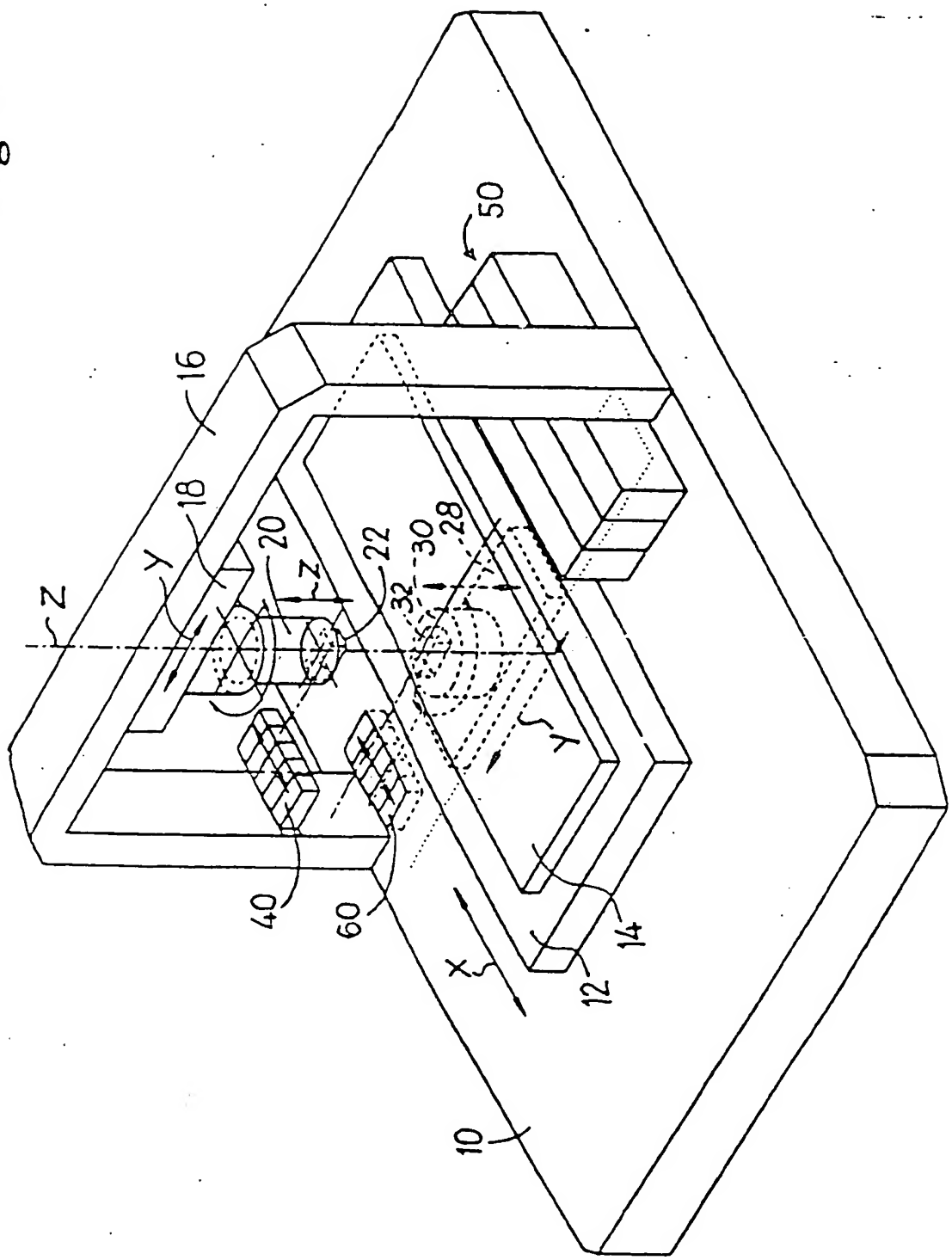
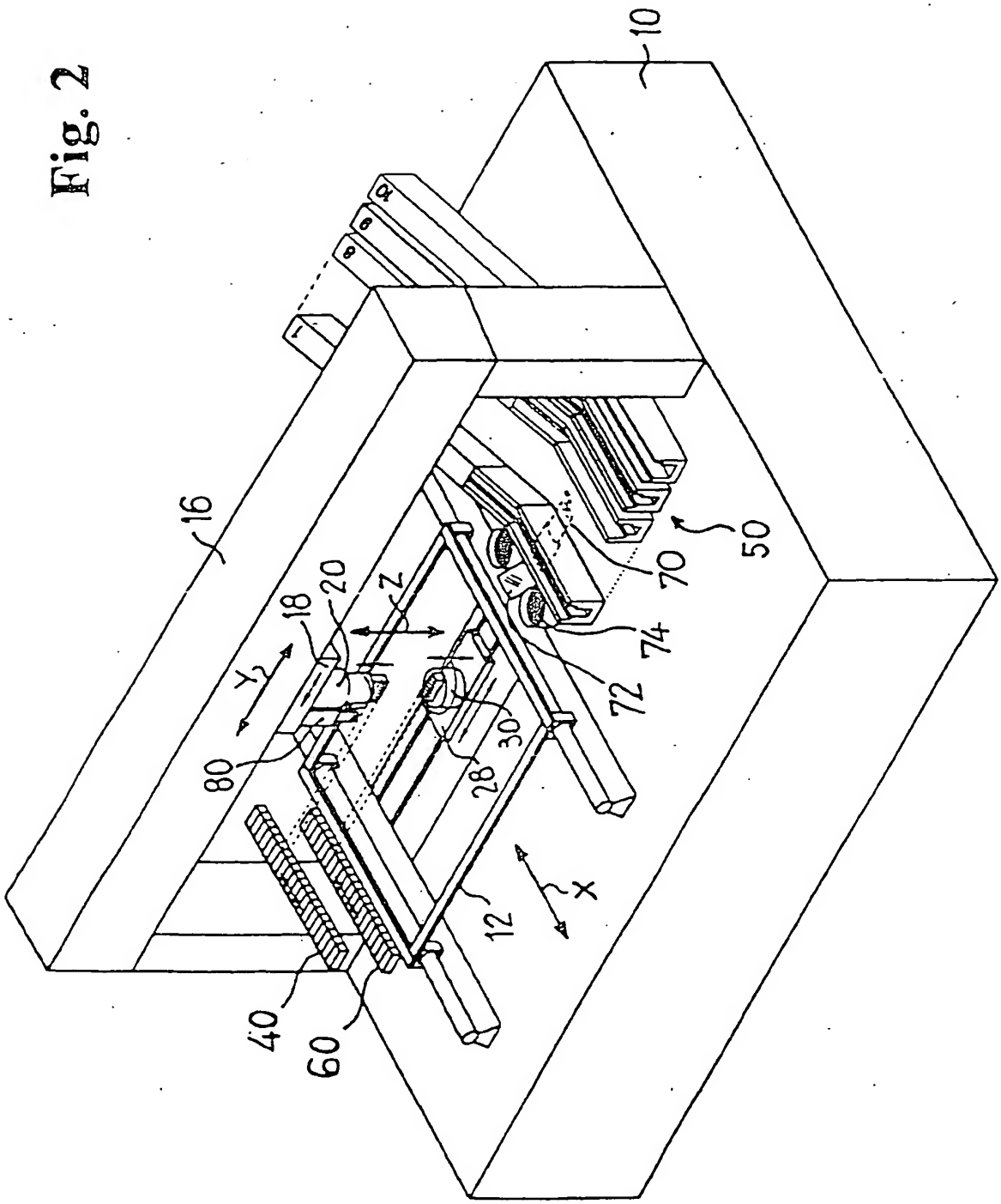


Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 96 87 0135

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 5 206 985 A (TSUKIHASHI ET AL.) 4 May 1993 * column 1, line 40 - column 2, line 68; figures 1,2,5,6 *	1-4,11	H05K13/08 H05K13/04
A	US 4 598 456 A (MCCONNELL) 8 July 1986 * column 1, line 35 - column 2, line 10; figure 1 *	1,3	
A	DE 39 21 052 A (FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG EV) 4 January 1990 * column 2, line 28 - column 3, line 41; figures 1-3 *	1,3	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H05K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 February 1997	Bolder, G

CATEGORY OF CITED DOCUMENTS

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